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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

Technical Report on Development of USTES Aptitude Test Battery

For . . . . . .

Welder, Combination (welding) 812.884-014
S-126
(Developed in Cooperation with the Minnesota, Texas, and Washington State Employment Services)

U. S. Department of Labor
Manpower Administration

May 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study # 731, 2172, 2780

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

FOR

Welder, Combination (welding) 812.884-014

S-126

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Welder, Combination (welding) 812.884-014. The following norms were established.

GATB Aptitudes	Minimum Acceptable GATB Scores
S - Spatial Aptitude	85
F - Finger Dexterity	85
M - Manual Dexterity	80

RESEARCH SUMMARY - VALIDATION SAMPLE

Sample:

The validation sample was comprised of two subsamples:

Subsample I - 33 male welding students enrolled in two vocational schools in Washington.

Subsample II - 51 male welding students enrolled in a college in Texas.

These studies were conducted prior to the requirement of providing minority group information. Therefore, minority group composition is unknown.

Criterion:

Instructor's ratings.

Design:

Concurrent (test and criterion data were collected at approximately the same time.

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity:

Phi Coefficient = .62 ($P/2 < .0005$)

Effectiveness of Norms:

Only 63% of the nontest-selected students used for this study were good students; if the students had been test-selected with the above norms, 87% would have been good students. 37% of the nontest-selected students used for this study were poor students; if the students had been test-selected with the above norms, only 23% would have been poor students. The effectiveness of the norms is shown in Table 1.

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Students	63%	87%
Poor Students	37%	23%

SAMPLE VALIDATION - VALIDATION STUDY

Size:

N = 84

Educational Status:

Students

Educational Institutions:

Subsample I - Students were enrolled in the Takoma Vocational and Technical School, Takoma, Washington or the Spokane Trade School, Spokane, Washington.

Subsample II - Students were enrolled at Del Mar College, Corpus Christi, Texas.

Selection Requirements:

Age: At least 16 years of age (specified by Washington institutions)
Education: None Specified
Tests: None Specified

Principal Activities:

The job duties of the occupation for which the students were being trained are shown in the Appendix.

Minimum Experience:

All students in the sample had completed at least 90 hours of class instruction.

TABLE 2

	Mean	SD	Range	Washington Sample	Texas Sample
Age (years)	24.9	6.3	16-45	.362*	.036
Education (years)	10.5	1.8	6-15	.184	.168

EXPERIMENTAL TEST BATTERY

All tests of the GATB, B-1001, were administered to the Washington samples during 1952. The B-1001 scores were converted to equivalent B-1002 scores. All 12 tests of the GATB, B-1002A, were administered to the Texas sample in 1957.

CRITERION

Subsample I: Special rating instructions and forms were prepared to obtain ratings since students in the sample did not have equal amount of class instruction. Raters were asked to eliminate those students who did not have enough class instruction to demonstrate their ability in the course. Then, the raters were also asked to rate students, in terms of their progress in the course, not in terms of present achievement. Rank order ratings were made and the students were also categorized as above average, average or below average. Reratings were obtained after a two-week interval.

The two sets of broad category ratings were combined to produce the following groups and numbers of students in each group: A = 9; AB = 3; AC and B = 8; BC = 6; and C = 7. For computational purposes, the broad category ratings of A, AB, AC and B, BC, and C were converted into quantitative scores of 62, 55, 50, 45, and 36, respectively.

Subsample II: The criterion consisted of instructors' ratings of the students' ability and progress in both class and shop work. The ratings of each of the instructors were combined by grouping all the students rated good, average, or poor in their respective categories. This resulted in 14 students being rated good, 19 average, and 18 poor. For computational purposes, the broad category ratings of good, average, and poor were converted into quantitative scores of 62, 51, and 39, respectively.

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 37% of the sample in the low group to correspond with the percentage of students considered unsatisfactory or marginal. Students in the high criterion group were designated as "good students" and those in the low group as "poor students." The criterion critical score is 50.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitude K which does not have a significant correlation with the criterion was included since it seemed to be important on the basis of the course description. Aptitudes N and Q which have significant correlation with the criterion were not considered for inclusion in the trial norms since there was no other qualitative or quantitative evidence of significance. Tables 3, 4, and 5 show the results of the qualitative and quantitative evidence.

TABLE 3

Qualitative Analysis

(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Required for learning and understanding the subject matter in the course.
S - Spatial Aptitude	Required for visualizing three-dimensional objects and for reading and interpreting blueprints and layouts.
K - Motor Coordination	Required to make effective use of hands and arms in using welding equipment.
F - Finger Dexterity	Required for fitting component parts of assemblies together.
M - Manual Dexterity	Required for rapid handling of pieces to be welded.

TABLE 4

Means, Standard Deviations (SD), Ranges for the Combined Sample, and Pearson Product-Moment Correlations with the Criterion (r) for each Subsample for the Aptitudes of the GATB N = 84

Aptitudes	Mean	SD	Range	r (Washington Sample)	r (Texas Sample)
G - General Learning Ability	95	16	55-132	.105	.379**
V - Verbal Aptitude	88	15	56-126	.054	.227
N - Numerical Aptitude	94	17	44-127	.160	.287*
S - Spatial Aptitude	105	16	61-137	.157	.639**
P - Form Perception	97	17	55-141	.209	.463**
Q - Clerical Perception	88	15	49-127	.123	.440**
K - Motor Coordination	95	19	45-138	.269	.209
F - Finger Dexterity	100	18	50-142	.604**	.579**
M - Manual Dexterity	100	18	55-146	.518**	.725**

* Significant at the .05 level

** Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	
Qualitative Analysis of Aptitudes Required	X			X			X	X	
Aptitudes with Relatively High Means				X				X	
Aptitudes with Relatively Low Standard Deviations									
Aptitudes with Significant r (Washington)								X	
Aptitudes with Significant r (Texas)	X		X	X	X	X		X	
Aptitudes to be Considered for Trial Norms	G			S	P		K	F	

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degrees to which trial norms consisting of various combinations of Aptitudes G, S, P F and M, at trial cutting scores, were able to differentiate between the of the sample considered good students and the 37% of the sample consid- poor students. Trial cutting scores at five-point intervals approximately standard deviation below the mean are tried because this will eliminate a one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviati below the mean will eliminate about one-third of the sample; for four-apti trial norms, cutting scores of slightly less than one standard deviation be the mean will eliminate about one-third of the sample. The Phi Coefficie was used as a basis for comparing trial norms. The optimum differentiati for the occupation of Welder, Combination (welding) 812.884-014 was provided by norms of S-85, F-85, and M-80. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .62 (statistic significant at the .0005 level).

TABLE 6

Concurrent Validity of Test Norms
S-85, F-85 and M-80

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	7	46	53
Poor Students	24	7	31
Total	31	53	84

Phi Coefficient (ϕ) = .62
Chi Square (X^2_y) = 31.9
Significance Level = $P/2 < .0005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements of incorporating the occupation studied into OAP-47 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. The OAP-47 norms of S-80, F-80 and M-85 yield a phi coefficient of .49.

CHECK STUDY RESEARCH SUMMARY SHEET

S-126 GATB #2780

Welder, Combination (welding) 812.884-014

Check Study Research Summary

Sample:

52 MDTA trainees enrolled in various combination Welder courses throughout the State of Minnesota. Three individuals were identified as Negroes, two were identified as Indians, 4 as Mexican Americans and 3 other individuals were classified as Spanish Americans. The remainder were non-minority group members.

TABLE 7

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with Criterion (r) for Age, Education and GATB Aptitudes for Check Study

	N	Mean	SD	Range	r
Age (years)	52	24.2	6.9	17-48	.094
Education (years)	52	9.7	2.2	4-12	-.148
G - General Learning Ability	48	93.0	14.6	69-125	.264
V - Verbal Aptitude	49	88.9	13.8	65-129	.161
N - Numerical Aptitude	49	90.9	15.3	61-132	.247
S - Spatial Aptitude	51	102.3	15.8	71-140	.309*
P - Form Perception	50	101.4	15.2	70-126	.539**
Q - Clerical Perception	49	98.6	12.2	78-126	.109
K - Motor Coordination	50	91.3	15.2	52-130	.111
F - Finger Dexterity	52	89.3	15.9	59-125	.346*
M - Manual Dexterity	52	93.8	17.3	61-132	.192

* Significant at the .05 level.
** Significant at the .01 level.

Criterion:

Instructor's ratings.

Design:

Longitudinal (test data were collected at the beginning of training and criterion data were collected in 1969 after the completion of training).

Principal Activities:

The course of study is shown in the appendix.

Predictive Validity:

Phi Coefficient = .30 ($P/2 < .025$).

Effectiveness of Norms:

Only 54% of the non-test-selected trainees used for this study were good trainees; if they had been test-selected with the S-126 norms, 69% would have been good trainees. 46% of the non-test-selected trainees used for this study were poor trainees; if they had been test-selected with the S-126 norms, only 31% would have been poor trainees. The effectiveness of the norms when applied to this independent sample is shown graphically in Table 8.

TABLE 8

Effectiveness of S-126 Norms on Check Study Sample

	Without Tests	With Tests
Good Trainees	54%	69%
Poor Trainees	46%	31%

TABLE 9

Predictive Validity of S-126 Norms on Check Study Sample

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Trainees	8	20	28
Poor Trainees	15	9	24
Total	23	29	52

Phi Coefficient (ϕ) = .30 Chi Square (χ^2_y) = 4.7

Significance Level = $P/2 < .025$

Course Descriptions for Validation Sample

APPENDIX

1. Sample I - Washington: welds steel, iron, aluminum, brass, bronze, and copper metals using acetylene and electrical arc (A.C. and D.C.), welding equipment.

   I. Related Instruction

      a. Safety
      b. Trade Mathematics
      c. Trade terminology
      d. Trade science
      e. Drawing and blueprint reading

   II. Practical Instruction

      a. Arc - A.C. Welding

         (1) Flat
         (2) Vertical
         (3) Overhead
         (4) Pipe

      b. Arc - D.C. Welding

         (1) Flat
         (2) Vertical
         (3) Overhead
         (4) Pipe

      c. Acetylene Welding

         (1) Flat
         (2) Vertical
         (3) Overhead
         (4) Pipe

2. Sample II - Texas: The course attended by the students in the sample consisted of a study of welding equipment, metal welding, blueprint reading, shop sketching, layout, safety factors, and electrodes, with particular stress given to layout for welding trades. The course outline is shown below:

(1) Classroom work will consist of at least one hour per day as follows:

	Courses	Hours
a.	Math for welders	20
b.	Drawing instruments and their uses (making scale drawings)	20
c.	Theory of welding	25
d.	Welding metallurgy	25
e.	Layout and fabrication of all pipe fittings, tees, ells, and reducers (eccentric and concentric), bull plugs (flat, blunt, and orange peel)	150
f.	Layout and fabrication of roof trusses made from pipe	45
g.	Layout of sheet metal cones, frustrums of cones round to squares, twisted rectangles, etc.	100
h.	Layout of pipe supports from angle iron and I beams	45
i.	Blueprint reading	50

(2) Oxy-Acetylene Welding

a.	Setting up apparatus, precautions, safety practices and operations of hand cutting torches	30
b.	Flat plate cutting and beveling	35
c.	Flat plate welding	
	1. Puddling flat bead without use of filler rod Puddling flat bead with use of filler rod	20
	2. Corner to corner V. Flat position	35
	3. Corner to corner V. Semi-Vertical	35
	4. Corner to corner V. Overhead	35
	5. V. Butt flat without filler	35
	6. V. Butt flat with filler rod	35
	7. V. Butt semi-vertical	35
	8. V. Butt horizontal	35
	9. V. Butt overhead	35
	10. Flat fillet	35
	11. V. Butt vertical	50
	12. Vertical fillet	50
	13. Overhead fillet	50

(3) Pipe Welding, Acetylene

a.	2" pipe in horizontal position rotating	50
b.	4" and 6" pipe in horizontal	100
c.	Pipe vertical all sizes	50

Courses	Hours
(4) Arc Welding	
a. Principles of the arc welder	20
b. Flat plate welding and cutting	
1. Striking and running flat beads (bare electrodes)	25
2. Running continuous bead (bare electrodes)	20
3. Weaving (bare electrode)	20
4. Padding (bare electrode)	20
5. Lap welding (bare electrode)	30
6. Tee or fillet weld (bare electrode)	30
7. V. Butt weld (bare electrode)	30
8. Vertical and overhead (bare electrode)	40
9. Shielded arc welding (running flat beads)	20
10. Padding	20
11. Lap Welds (flat position)	30
12. Fillet (vertical position)	40
13. Fillet (flat position)	30
14. Fillet (overhead position)	40
15. V. Butt (vertical position)	40
16. V. Butt (flat position)	40
17. V. Butt (overhead position)	55
19. V. Butt (horizontal position)	40
(5) Pipe Welding, Electric	
a. Cutting and beveling	150
b. Axis of pipe horizontal-pipe-rotating	50
c. Axis of pipe horizontal fixed beading (To start at bottom and progressing upward)	150
d. Axis of pipe vertical weld horizontal	100
e. Axis of pipe horizontal beading from top to bottom	100
(6) Welding Special Metals -- Aluminum, Stainless Steel, Cast Iron, Carbon Arc, and Hard Surfacing	30

Course Description for Check Study Sample

Unit I	Clock Hours
1. Safety - Industrial Relations	15
2. Basic Math I - Addition, Multiplication, Fractions, Subtraction, Division	25
3. Basic Blueprint Reading for Welding	25
4. Welding Theory - Techniques	25
5. Flame Cutting - Line, Hole Bevel	5
6. Oxyacetylene Welding - Sheet Metal (flat, vertical, overhead), Heavy Plate (flat only), Brazing	60
7. Arc Welding 6010 - 6013 - 7024 -- Flat, Vertical, Overhead	285
8. Mig (wire) Welding	40

Unit II	Clock Hours
1. Basic Hand Tools and Safety	15
2. Basic Math II - Decimals, Area, Volume, Square Root	25
3. Advanced Blueprint Reading for Welders	25
4. Welding Theory II - Ferrous, Nonferrous Metals, Welding Processes	25
5. Flame Cutting - Automatic Arc	5
6. Oxyacetylene - Pipe, Brazing, Silver Soldering	50
7. Arc Welding II 7018 - Mild Steel, Flat Position, Horizontal, Vertical, Overhead	230
8. Stainless	16
9. Cast Iron	9
10. Steel Pipe	40
11. Tig Steel, Stainless, Alum.	40
Total	960

DESCRIPTIVE RATING SCALE FOR TRAINEES
Cross-Validation Sample

A. QUALITY Consider all the work he has produced that you have seen. How does quality of his work compare with that produced by all other students you've had in this course?

1. definitely limited 2. somewhat limited 3. average
4. above average 5. outstanding

B. QUANTITY Consider the rate at which he has completed assigned tasks. In this respect, how does he compare with all the other students you've had in this course?

1. definitely limited 2. somewhat limited 3. average
4. above average 5. outstanding

C. LEARNING ABILITY Consider the ease with which he has learned and understood the subject matter covered in this course. How does he compare with all other students in this respect?

1. definitely limited 2. somewhat limited 3. average
4. above average 5. outstanding

D. PERFORMANCE ABILITY Consider the ease with which he has performed the operations involved in completing his assigned tasks. In this respect, how does he compare with all the other students you've had in this course?

1. definitely limited 2. somewhat limited 3. average
4. above average 5. outstanding

E. OVERALL ACCOMPLISHMENT Considering only those factors upon which he has been rated, how does he compare with other students in his overall success in acquiring the skills and knowledge required in this course?

1. definitely limited 2. somewhat limited 3. average
4. above average 5. outstanding

May 1970 S-126

FACT SHEET

Job Title

Welder, Combination (welding) 812.884-014

Job Summary

Fuses (welds) metal parts together, using either electric-arc or oxyacetylene welding equipment to melt both the metal edges to be joined and the welding rod which supplies the extra metal needed to form smooth joints.

Work Performed

Prepares workpiece for welding: Places articles to be welded on workbench, floor, in a supporting rack or clamp, or against the structure or piece of equipment to which weld is to be made. Cleans area around joint to be welded with a wire brush and rags, occasionally using hammer and chisel to remove encrusted scale and dirt.

Sets up welding equipment: If using oxyacetylene welding equipment, connects pressure regulators to nozzles of oxygen and acetylene supply tanks, connects hose to regulators, and fits welding torch to the hose. Selects welding tip of size suitable to work to be done, and screws it into torch. Opens regulator valves and lights torch. Adjusts flame to hottest degree possible (neutral or plate blue color) by adjusting regulator valves. If using electric-arc welding equipment, connects electrode holder to cable leading to motor-generator or transformer, adjusts power controls to amperage suitable for the type and thickness of metal to be welded. Connects ground cable from power unit to metal to be welded and adjusts welding rod (electrode) to proper position in holder. In either type of welding, if work is to be done in confined space or on galvanized metal, sets up exhaust vent to draw off dangerous welding fumes. Places protective helmet on head to safeguard eyes from blinding light, ultraviolet rays, and fumes.

Welds metal parts together with oxyacetylene welding equipment: When necessary, preheats metal surrounding the point or line where weld is to be made, using gas blowtorch, charcoal fire, or other source of heat, so as to decrease the internal stresses in the metal which would be caused by the sudden application of intense welding temperatures. Applies welding flame to a small spot of the joint, moving torch slightly back and forth until the metal begins to melt, then holds end of welding rod to the melted area so that the rod begins to melt also, adding to the puddle of molten metal. Moves flame and rod forward along line to be welded, keeping just ahead of the spot where the molten metal is followed by molten slag. Welds in horizontal, vertical, or overhead positions, as required. May sprinkle flux (powdered borax, lime, or other material to promote fusion) on the molten weld, or dip the welding rod in flux so that a continuous supply is fed into the molten metal. Allows weld to cool thoroughly before subjecting it to any strains or usage. May clean the weld with a wire brush or hammer and chisel.

Welds metal parts together with electric-arc welding equipment: When necessary, preheats surrounding the point or line where weld is to be made. Strikes or draws an electric arc by bringing the electrode tip in contact with the metal and then quickly lifting tip slightly above the metal surface. Moves arc along the line to be welded, keeping the electrode tip a constant distance away from the metal, determining proper distance by the sound of the arc. (Correct distance creates crackling sound, too great a distance will give a blowing or humming sound, while too close a distance results in the electrode becoming stuck to the metal.)

May cut metal with torch: May cut up scrap metal, trim edges of girders, or cut holes or patterns in metal by use of oxyacetylene torch, slow passing the flame along lines drawn on metal which indicate where cuts should be made. May send melted-off pieces of metal to scrap heap.

May do brazing and lead burning: May braze steel, cast iron, copper, and various alloys by means of oxyacetylene or electric-arc welding equipment, using a slightly different welding technique from that used with ordinary ferrous metals. When using gas equipment, adjusts torch to burn with an oxidizing flame (higher percentage of oxygen), and slowly heats the area around the joint to be welded until red hot. Applies bronze rod dipped in flux to the flame and guides flow of molten bronze along the joint, attempting to complete the entire weld in a single continuous pass, as successive re-heatings and passes tend to weaken the weld. When using electric-arc equipment, uses nonmelting carbon rod as the electrode, and applies a hand-held bronze rod to the arc so that it will melt and run along the joint. May do lead burning in connection with manufacture of such lead articles as storage batteries, using oxyacetylene equipment and carefully controlling flame so as not to melt the lead parts.

Effectiveness of the Norms

Validation Sample: Only 63% of the non-test-selected students used for this study were good students; if the students had been test-selected with the S-126 norms, 87% would have been good students. 37% of the non-test-selected students used for this study were poor students; if the students had been test-selected with the S-126 norms, only 13% would have been poor students.

Cross Validation Sample: Only 54% of the non-test-selected trainees used for this study were good trainees; if the trainees had been test-selected with the S-126 norms, 69% would have been good trainees. 46% of the non-test-selected trainees used for this study were poor trainees; if the trainees had been test-selected with the S-126 norms, only 31% would have been poor trainees.

Applicability of S-126 Norms

The aptitude test battery is applicable to jobs which include a majority of duties described above.

GPO 898-820